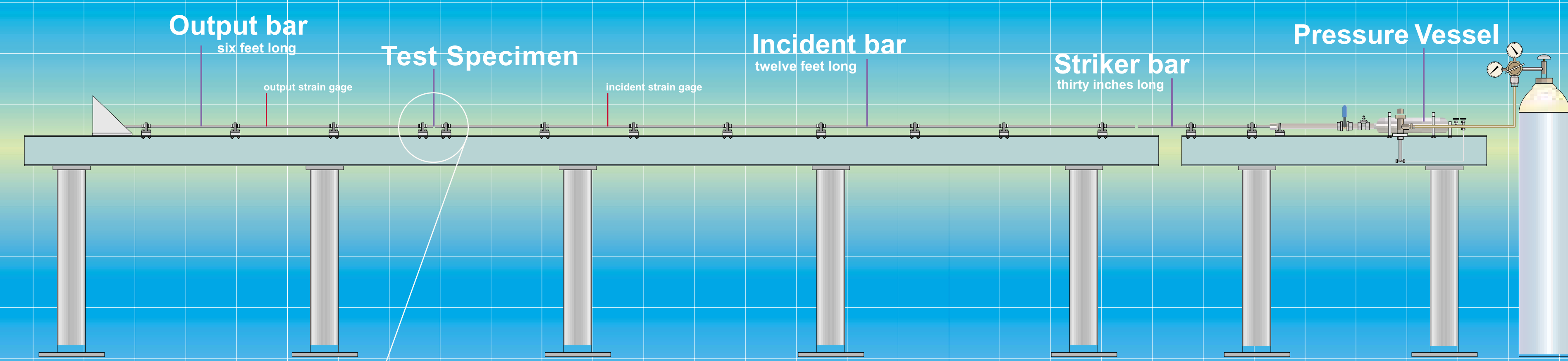
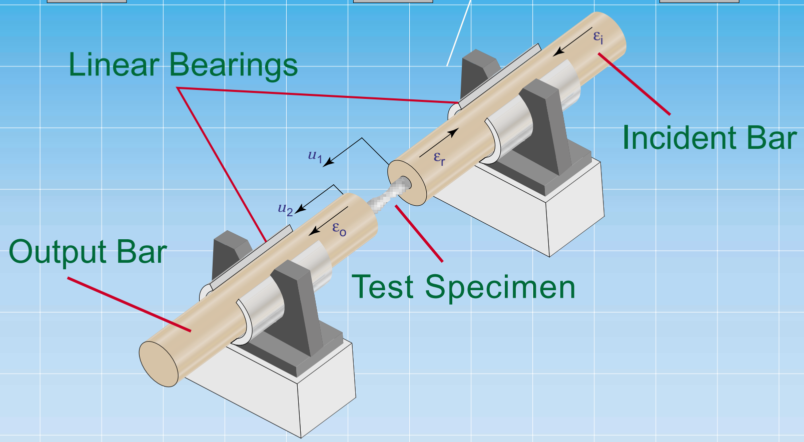
Structures & Acoustics Division

SPLIT HOPKINSON BAR APPARATUS





Split Hopkinson Bar Theory

The Split Hopkinson bar apparatus consists of a striker bar, an incident bar, the test specimen, and the output bar. A rectangular compression wave of well defined amplitude and length is generated in the incident bar when it is struck by the striker bar. When the wave reaches the specimen some of it transmits through it and some if it reflects back through the incident bar. One dimensional wave propagation analysis determines high strain rate stress-strain curves from measurements of strain in the incident and output bars.

*Stress-Strain Curves are Derived from Strain Gage Measurements **

The velocity of any point of the incident bar is:

$$\dot{u} = c(-\varepsilon_i + \varepsilon_r) \qquad (1)$$

The velocity in the output bar is:

$$\dot{u} = -c\,\varepsilon_o \qquad (2)$$

The strain rate in the specimen is calculated from:

$$\dot{\varepsilon} = \frac{(\dot{u}_1 - \dot{u}_2)}{l_s} = \frac{c}{l_s}(-\varepsilon_i + \varepsilon_r + \varepsilon_o) \qquad (3)$$

The forces in the two bars are:

$$F_1 = AE(\varepsilon_i + \varepsilon_r) \qquad (4)$$

$$F_2 = AE\,\varepsilon_o \qquad (5)$$

Equating (4) and (5) gives:

$$\varepsilon_o = \varepsilon_i + \varepsilon_r \qquad (6)$$

Substituting (6) into (3) provides a relationship to calculate strain rate in the specimen:

$$\dot{\varepsilon} = \frac{2c\,\varepsilon_r}{l_s} \qquad (7)$$

Stress in the specimen is calculated by dividing the force in (5) by the cross-sectional area.

$$\sigma(t) = \frac{AE\,\varepsilon_o}{A_s} \qquad (8)$$

* Gray, George T. (Rusty) III, High Strain-Rate Testing of Materials: The Split Hopkinson Bar. Methods in Materials Research, John Wiley Press, Oct. 1997.

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